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Kruger et al.

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(54) **EXPANDABLE BRUSH**

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(52) **U.S. Cl.**
CPC ***E21B 37/02*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 37/02; E21B 37/04
See application file for complete search history.

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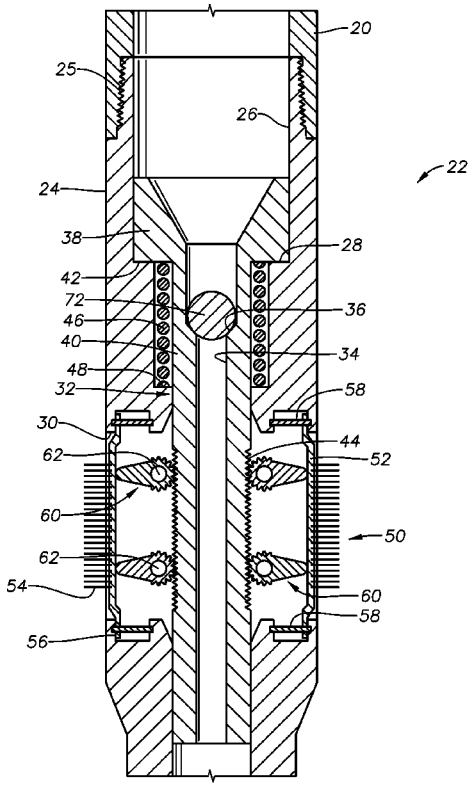
(57) **ABSTRACT**

Expandable brushes for cleaning a surrounding tubular member. Brushes include a housing to be disposed within the surrounding tubular member and a brush shoe that retains at least one brush bristle, the brush shoe being radially moveable with respect to the housing between a radially retracted position and a radially expanded position.

7 Claims, 7 Drawing Sheets



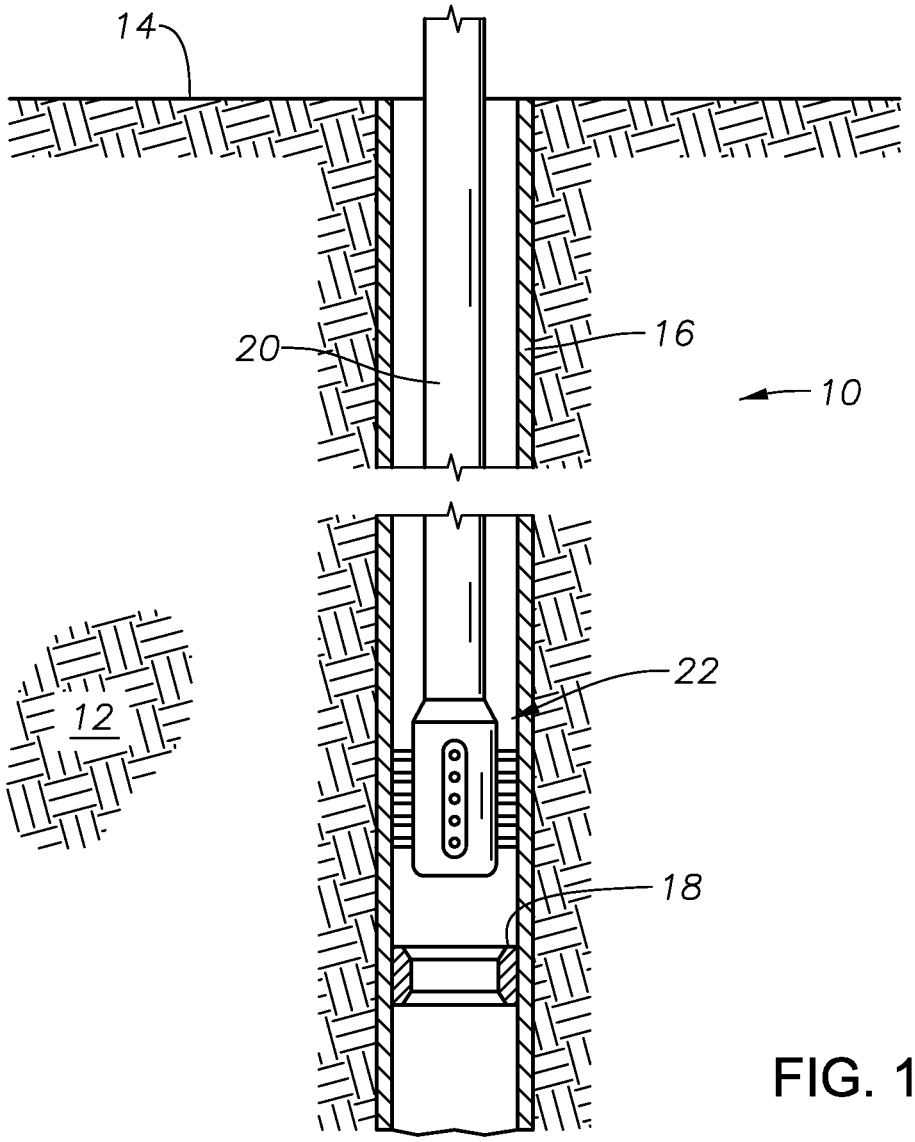


FIG. 1

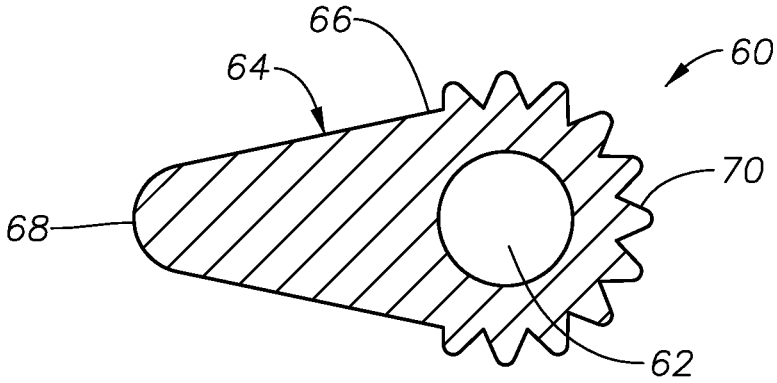


FIG. 4

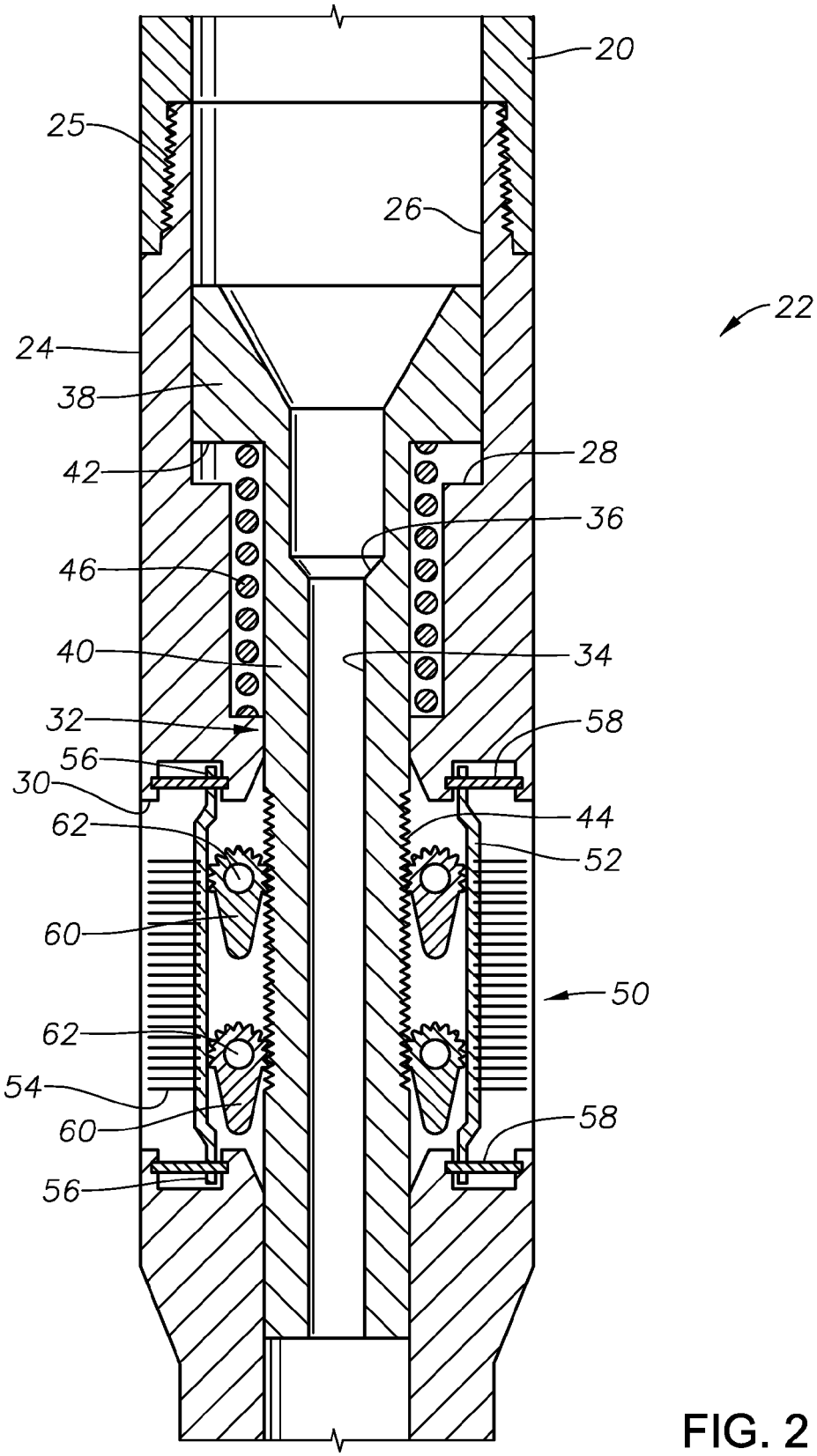

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FIG. 2

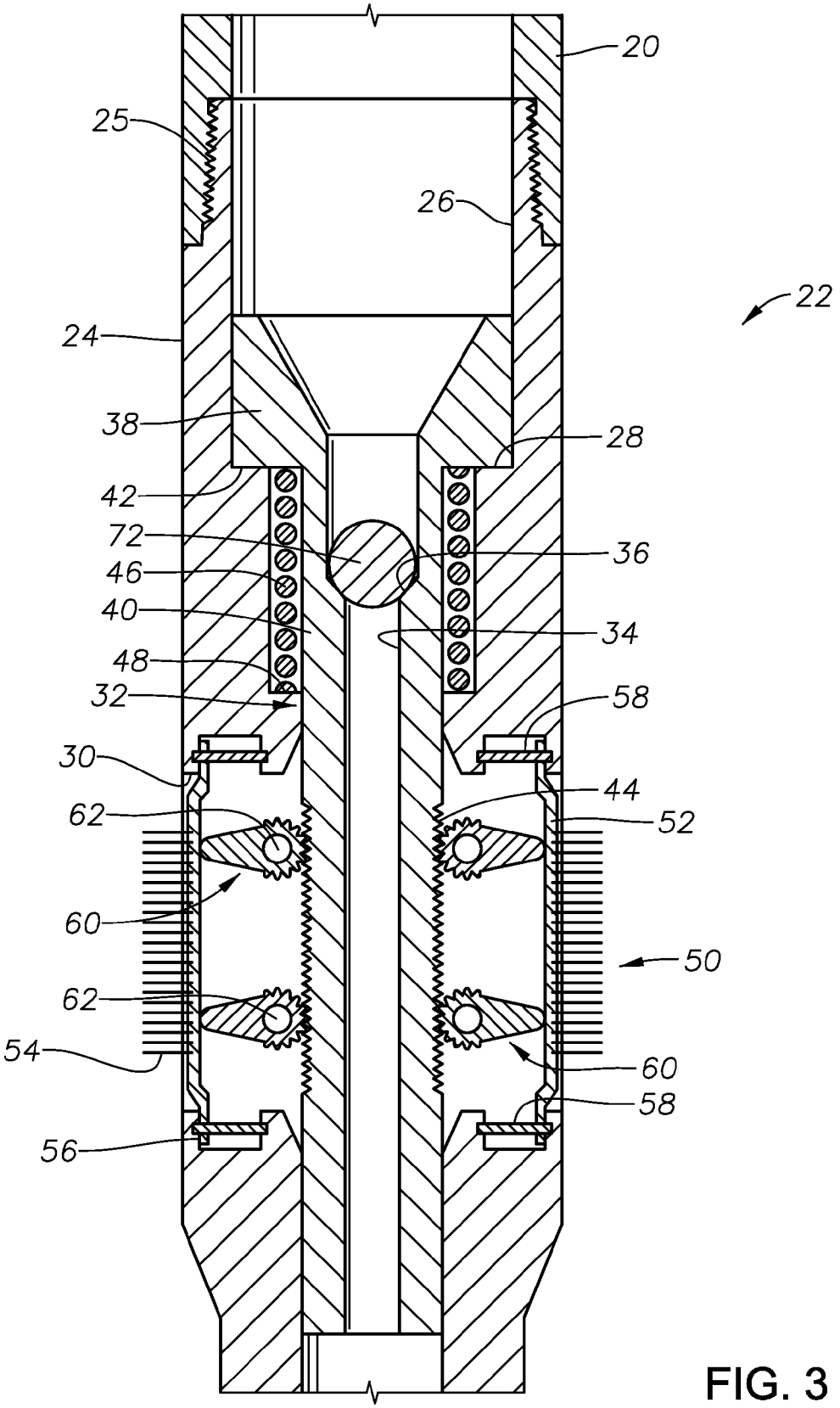
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FIG. 3

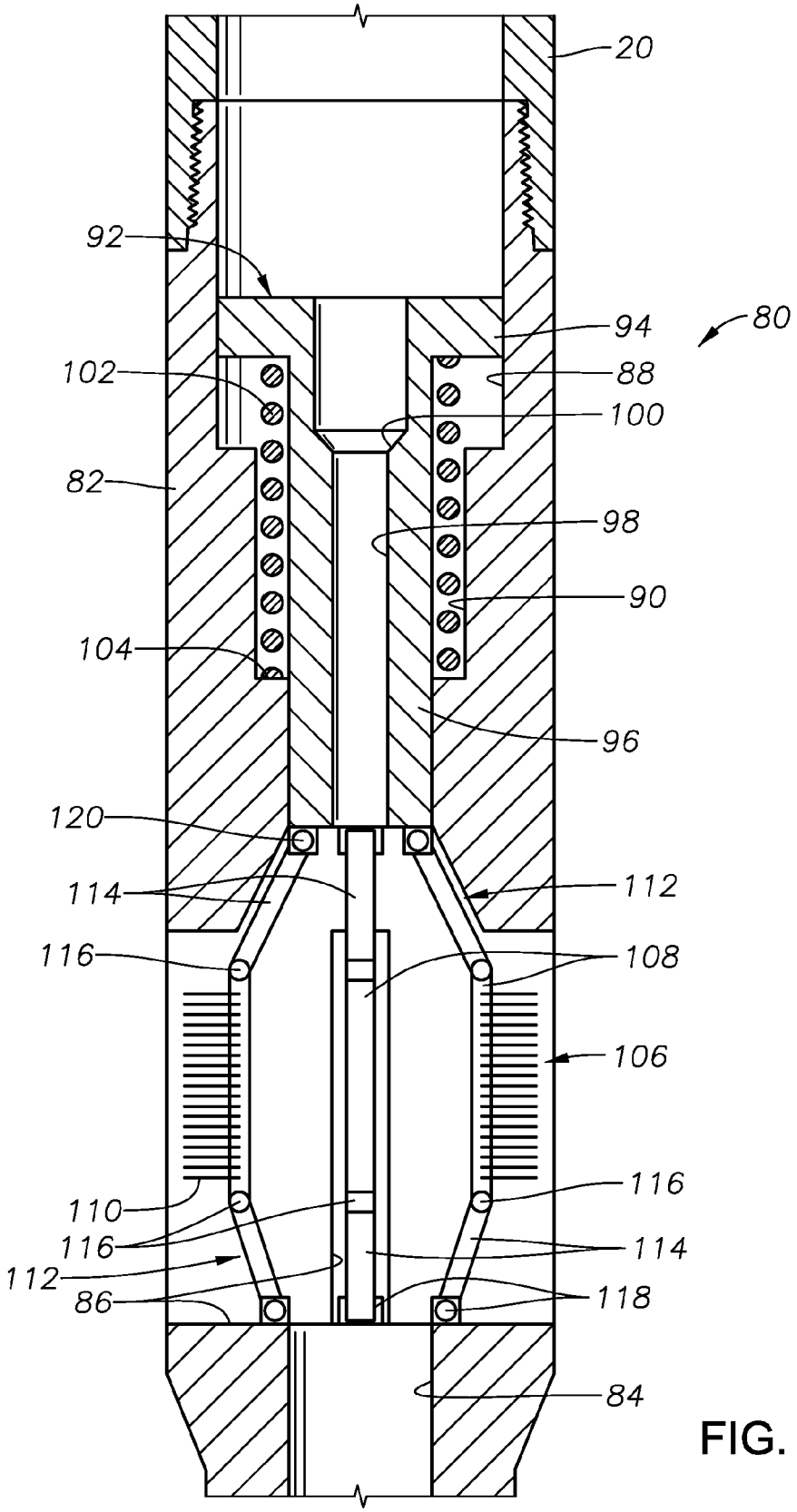
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FIG. 5

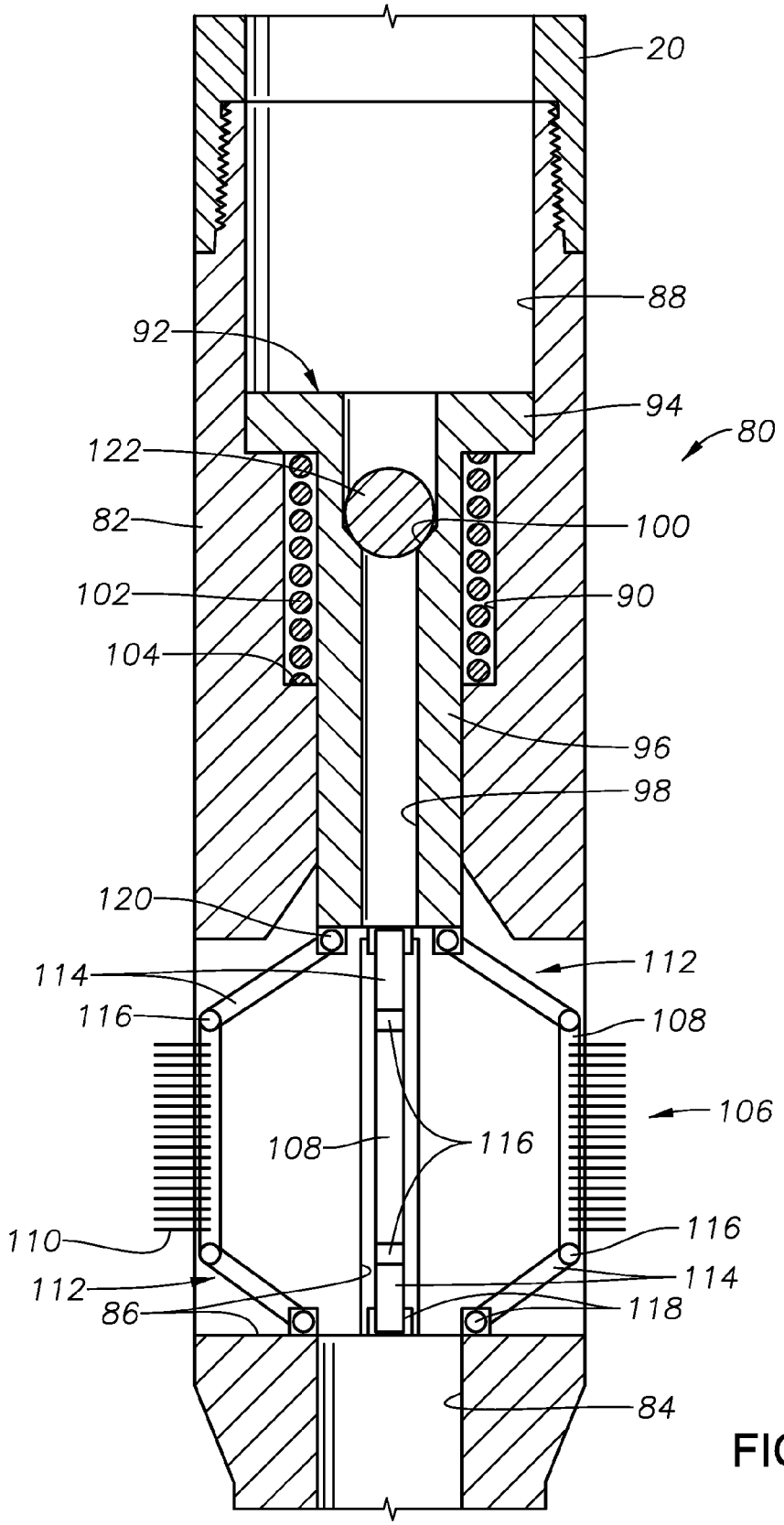
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FIG. 6

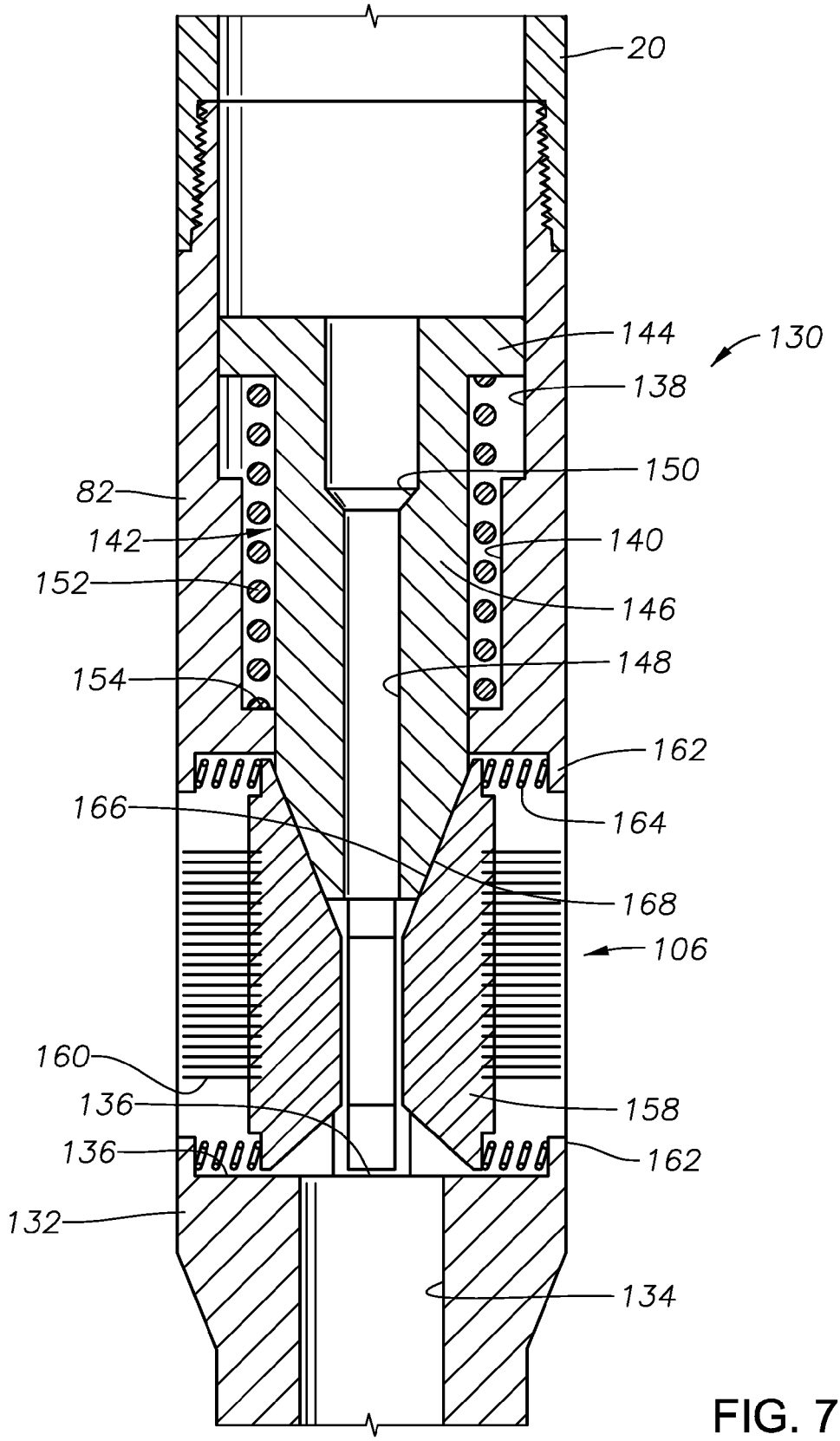
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FIG. 7

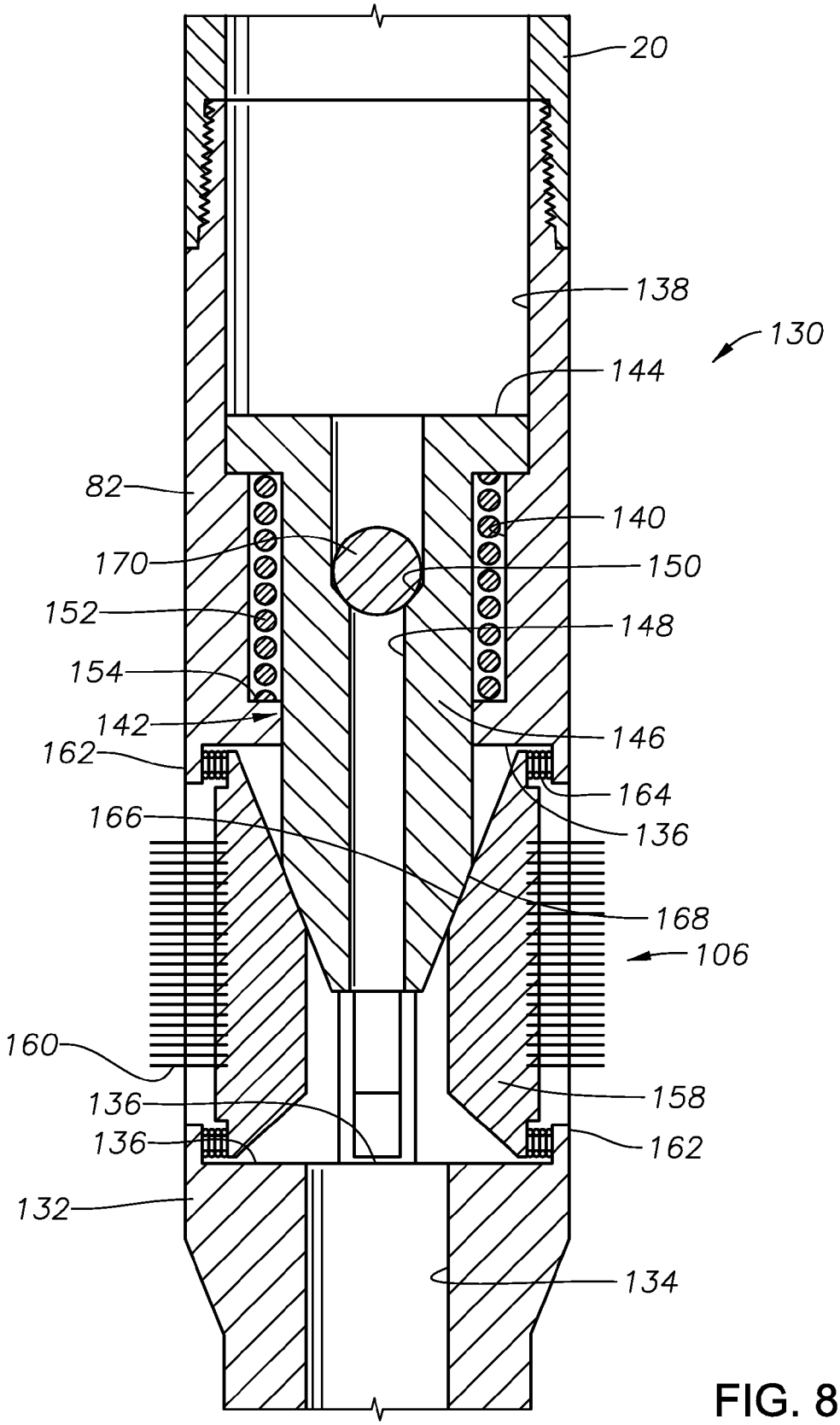
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FIG. 8

EXPANDABLE BRUSH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to brushes used for cleaning wellbores and subterranean tubular members.

2. Description of the Related Art

Brushes are used to clean and remove debris from wellbore casings, liners and other tubular members in a wellbore. A common occurrence requires these tools to pass through restrictions in the diameter of the tubular member being cleaned. Many conventional tools rely upon the flexibility of brush bristles to allow the brush to pass through such restrictions. In practice, unfortunately, damage often occurs easily to the bristles of downhole brush tools as they are passed through tubular restrictions.

SUMMARY OF THE INVENTION

The invention provides devices and methods for protecting the bristles of downhole brushes during operation. Downhole expandable brushes are described which include a housing that can be affixed to a running string and a brush assembly with at least a single set of brush bristles that extend outwardly through the housing and can be radially extended with respect to the housing to radially expand the brush. Additionally, the bristles of the brush may be radially retracted with respect to the housing so that the brush may be passed through restrictions in the surrounding tubular member without damaging the bristles. According to described embodiments, axial movement of a piston member with respect to the housing in a first axial direction causes the brush assembly to move radially outwardly while axial movement of the piston member with respect to the housing permits the brush assembly to retract radially with respect to the housing.

According to a first exemplary embodiment, the housing of the brush defines an interior axial flowbore through which fluid can be flowed. A piston member is retained within the flowbore and is axially moveable therein. Axial movement of the piston member with respect to the housing rotates one or more cams having eccentric profiles. The cam(s) will urge a brush assembly, having a shoe and bristles, radially outwardly. Reverse rotation of the cam(s) will permit the brush member to retract into the housing.

In a second described embodiment, a piston member is retained within the flowbore and is operably interconnected with a flexible linkage. Axial movement of the piston member with respect to the housing causes the linkage to flex and move a brush member radially outwardly. Reverse axial movement of the piston member will cause the linkage to unflex and move the brush member radially inwardly with respect to the housing.

According to a third embodiment, a brush member is mounted upon a shoe, which has an angled inwardly-directed ramp surface. A piston member is moveably disposed within a flowbore of the housing and presents an angled or conical surface which contacts the ramp surface of the shoe. Axial movement of the piston member moves the shoe and affixed bristles radially outwardly with respect to the brush housing.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and further aspects of the invention will be readily appreciated by those of ordinary skill in the art as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference characters designate like or similar elements throughout the several figures of the drawing and wherein:

FIG. **1** is a side, cross-sectional view of an exemplary wellbore containing a running string with an affixed downhole brush tool in accordance with the present invention.

FIG. **2** is a side, cross-sectional view of an exemplary expandable brush in accordance with the present invention in a reduced diameter condition.

FIG. **3** is a side, cross-sectional view of the brush shown in FIG. **2**, now in an expanded diameter condition.

FIG. **4** is a detail view of a cam member used within the brush shown in FIGS. **1-2**.

FIG. **5** is a side, cross-sectional view of an exemplary alternative embodiment for an expandable brush in accordance with the present invention in a reduced diameter configuration.

FIG. **6** is a side, cross-sectional view of the brush shown in FIG. **5**, now in a radially expanded condition.

FIG. **7** is a side, cross-sectional view of another exemplary alternative embodiment for an expandable brush in accordance with the present invention in a reduced diameter configuration.

FIG. **8** is a side, cross-sectional view of the brush shown in FIG. **7**, now in a radially expanded condition.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates an exemplary wellbore **10** that has been drilled through the earth **12** from the surface **14**. The wellbore **10** is lined with metallic casing **16** of a type known in the art. The casing **16** presents a diametrical restriction **18**. It is desired to clean or polish casing **16**, particularly below the restriction **18**.

A running string **20** is shown disposed into the wellbore **10** from the surface **14**. The running string **20** may be coiled tubing or be made up of conventional drill string tubulars or have other constructions known in the art. An expandable brush **22** is shown affixed to the running string **20**.

A first exemplary expandable brush **22** is illustrated in FIGS. **2** and **3**. The brush **22** includes a generally cylindrical outer housing **24** which is affixed to the running string **20** via threaded connection **25**. The housing **24** is shaped and sized to fit within a surrounding tubular member which it is desired to clean, such as casing **16**. The housing **24** has an axial fluid flowbore **26** defined along the length of the housing **24**. An axially-facing stop shoulder **28** is formed within the flowbore **26**. Lateral windows **30** are formed within the housing **24**. In the depicted embodiment, there are two windows **30** shown. It should be understood, however, that this is for illustrative purposes only, and that there may be more or fewer than two windows **30** in practice. A piston member **32** is disposed within the flowbore **26**. The piston member **32** includes an inner axial fluid passage **34** along its length. A ball or plug seat **36** is formed within the fluid passage **34**. The piston member **32** presents an enlarged diameter section **38** and a reduced diameter section **40** which extends axially downwardly from the enlarged diameter section **38**. A downward-facing shoulder **42** is presented on the outer radial surface of the piston member **32** between the enlarged diameter and reduced diameter sections **38**, **40**. The reduced diameter section **38** presents a radially outer toothed or notched profile **44**.

A compression spring **46** is disposed radially between the outer housing **24** and the piston member **32**. The compression spring **46** is located axially between the downward-facing shoulder **42** and an upward-facing shoulder **48** that is formed within the flowbore **26**.

A brush assembly **50** is disposed within each of the windows **30**. Each brush assembly **50** includes a brush shoe **52** that is shaped and sized to reside within its window **30** and be radially moveable inwardly and outwardly within the window **30**. Bristles **54** are fixedly secured within each shoe **52** and extend radially outwardly therefrom. In a currently preferred embodiment, each shoe **52** has perforated end portions **56** which are slidably mounted upon rods **58** that are embedded within the outer housing **24**. This permits the shoes **52** to move radially inwardly and outwardly through the windows **30**.

Rotatable cams **60** are also located within each of the windows **30** which are used to cause the brush assemblies **50** to be moved radially outwardly through the windows **30** when desired or withdrawn radially within the windows **30** when desired. In the depicted embodiment, there are two cams **60** shown located within each of the windows **30**. However, it should be understood that there may be more or fewer than two such cams **60** for each window **30** or for each shoe **52**, as desired. Each of the cams **60** rotate about a central pivot **62**. As best seen in FIG. **4**, each cam **60** features an eccentric outer profile **64** having a radially reduced profile portion **66** and an extended radius profile portion **68**. The outer profile **64** of each cam **60** also features a toothed or notched portion **70** having teeth or notches that are shaped and sized to interfit with the teeth or notches of the toothed or notched profile **44** of the piston member **32** in a complementary manner.

The expandable brush **22** may be moved between a radially reduced configuration and a radially expanded configuration. In the radially reduced configuration (FIG. **2**), the shoes **52** and bristles **54** are radially withdrawn within the outer housing **24**, thereby permitting the brush **22** to be passed through wellbore restrictions, such as diametrical restriction **18** in FIG. **1**. In the radially expanded configuration, the shoes **52** and bristles **54** are extended radially outwardly through their respective windows **30** in the housing **24** (see FIG. **3**).

In order to cause the brush assemblies **50** of the brush **22** to be moved radially outwardly to the position shown in FIG. **3**, a ball **72** is dropped into the running string **20** and enters the flowbore **26** of the brush **22**. The ball **72** lands on the ball seat **36** of the piston member **32** and blocks fluid flow downwardly through the fluid passage **34**. Thereafter, the running string **20** can be pressurized to cause the piston member **32** to move axially downwardly within the flowbore **26** until the downward-facing shoulder **42** of the piston member **32** is brought into abutting contact with the stop shoulder **28** of the outer housing **24**. Compression spring **46** is compressed.

As the piston member **32** is moved axially downwardly within the housing **24**, the toothed or notched interface between profile **44** and the toothed or notched portion **70** of the cams **60** cause the cams **60** to be rotated about their pivots **62**. The cams **60** are rotated from a position wherein the reduced profile portion **66** is adjacent the shoe **52** of the brush assembly **50** (see FIG. **2**) to a position wherein the extended radius profile portion **68** is adjacent the shoe **52** (see FIG. **3**), thereby moving the brush assembly **50** radially outwardly through its window **30**.

In order to return the brush **22** to its reduced diameter configuration, fluid pressurization within the running string **20** is stopped. The compression spring **46** will urge the piston member **32** axially upwardly within the flowbore **26** of the outer housing **24**. As the piston member **32** is moved axially upwardly the cams **60** are rotated in a reverse direction back to their original positions, thereby permitting the brush assemblies **50** to be moved radially inwardly to the positions illustrated in FIG. **2**.

FIGS. **5** and **6** illustrate an alternative expandable brush **80**. The brush **80** includes an outer housing **82** with axial flowbore **84** defined along its length. Lateral windows **86** are formed within the housing **82**. A radially enlarged piston chamber **88** and spring chamber **90** are formed within the flowbore **84**. A piston member **92** resides within the piston chamber **88** and spring chamber **90** and is axially moveable therewithin. The piston member **92** includes a radially enlarged upper portion **94** and a radially reduced lower portion **96**. An axial fluid passage **98** is formed within the piston member **92**. Ball seat **100** is formed within the fluid passage **98**.

A compression spring **102** resides within the spring chamber **90** to radially surround the lower portion of the piston member **92**. The spring **102** is bounded at the upper end by the enlarged diameter upper portion **94** of the piston member **92** and at its lower end by a shoulder **104** formed in the housing **82** at the lower end of the spring chamber **90**. Thus, the compression spring **102** urges the piston member **92** upwardly with respect to the housing **82**.

Brush assemblies **106** are movably disposed within each window **86**. In the depicted embodiment, there are four windows **86** (three visible) formed within the housing **82** and a brush assembly **106** is associated with each window **86**. However, it should be understood that there may be more or fewer than four windows **86** and brush assemblies **106**. Each of the brush assemblies **106** features a brush shoe **108** with bristles **110** extending radially outwardly therefrom. Each of the brush assemblies **106** also includes a flex linkage **112** that is made up of articulated arms **114** and pivot points **116** which join lower arms **114** to the shoe **108**. In the depicted embodiment, there are two arms **114** which support each shoe **108**. Pivot points **118** join the arms **114** to the housing **82**. Pivot points **120** is affixed to the piston member **92**. Thus, downward movement of the piston member **92** will cause the arms **114** to move about their pivot points **116**, **118** and **120** so that the shoe **108** and bristles **110** are moved radially outwardly through their respective window **86** (FIG. **6**).

In order to move the brush **80** from the radially retracted position (FIG. **5**) to the radially expanded position (FIG. **6**), a ball **122** is dropped into the running string **20** from surface **14**. The ball **122** lands on the ball seat **100**, and the running string **20** is pressured up behind the ball **122** urging the piston member **92** axially downwardly within the housing **82** and compressing spring **102**. The flex linkage **112** is articulated so that the shoe **108** and bristles **110** are moved radially outwardly. To return the brush **80** to the radially reduced configuration, the running string **20** is unpressurized, allowing the compression spring **102** to urge the piston member **96** axially upwardly and returning the brush **80** to the reduced diameter configuration shown in FIG. **5**.

FIGS. **7** and **8** depict a further alternative expandable brush **130**. The brush **130** includes a housing **132** having axial flowbore **134** defined along its length. Lateral windows **136** are formed within the housing **132**. A radially enlarged piston chamber **138** and spring chamber **140** are formed within the flowbore **134**. A piston member **142** resides within the piston chamber **138** and spring chamber **140** and is axially moveable therewithin. The piston member **142**

includes a radially enlarged upper portion **144** and a radially reduced lower portion **146**. An axial fluid passage **148** is formed within the piston member **142**. Ball seat **150** is formed within the fluid passage **148**.

A compression spring **152** resides within the spring chamber **140** to radially surround the lower portion **146** of the piston member **142**. The spring **152** is bounded at the upper end by the enlarged diameter upper portion **144** of the piston member **142** and at its lower end by a shoulder **154** formed in the housing **132** at the lower end of the spring chamber **140**. Thus, the compression spring **152** urges the piston member **142** upwardly with respect to the housing **132**.

Brush assemblies **156** are movably disposed within each window **136**. In the depicted embodiment, there are four windows **136** (three visible) formed within the housing **132** and a brush assembly **156** is associated with each window **136**. However, it should be understood that there may be more or fewer than four windows **136** and brush assemblies **156**. Each of the brush assemblies **156** features a brush shoe **158** with bristles **160** extending radially outwardly therefrom. Each brush shoe **158** is shaped and sized to be moveable radially inwardly and outwardly through its respective window **136**. Preferably, a retainer lip **162** is formed at the periphery of each window **136** to prevent the brush shoe **158** from being lost outside of the housing **132**. Compression spring **164** biases the brush shoe **158** radially inwardly.

Each brush shoe **158** presents a radially-inward facing angled ramp face **166**. The lower portion **146** of the piston member **142** presents an angled or conical surface **168** that contacts the ramp faces **166** of the brush shoes **158**. Due to the interface of the angled surface **168** and ramp faces **166**, downward axial movement of the piston member **142** within the housing **132** will move the brush shoes **158** and bristles **160** radially outwardly with respect to the housing **132**.

In order to move the brush **130** from the radially retracted position (FIG. **7**) to the radially expanded position (FIG. **8**), a ball **170** is dropped into the running string **20** from surface **14**. The ball **170** lands on the ball seat **150**, and the running string **20** is pressured up behind the ball **170** urging the piston member **142** axially downwardly within the housing **132** and compressing spring **152**. The brush shoes **158** and bristles **160** are moved radially outwardly. To return the brush **130** to the radially reduced configuration, the running string **20** is unpressurized, allowing the compression spring **152** to urge the piston member **142** axially upwardly and returning the brush **130** to the reduced diameter configuration shown in FIG. **7**.

The foregoing description is directed to particular embodiments of the present invention for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope and the spirit of the invention.

What is claimed is:

1. An expandable brush for cleaning a surrounding tubular member, the brush comprising:

a housing to be disposed within the surrounding tubular member;

an axial flowbore formed within the housing;

a piston member disposed within and axially moveable within the flowbore;

a brush shoe that retains at least one brush bristle, the brush shoe being radially moveable with respect to the housing between a radially retracted position and a radially expanded position;

a rotatable cam member operably associated with the brush shoe and the piston member so that axial movement of the piston member will rotate the cam member to cause the brush shoe to be moved radially with respect to the housing;

the rotatable cam member presenting a notched portion that interfits with a notched profile of the piston member;

the rotatable cam member further presenting an eccentric outer profile having a radially reduced profile portion and an extended radius profile portion and wherein axial movement of the piston member in a first axial direction moves the brush shoe radially outwardly by rotating the rotatable cam member from a position wherein the reduced profile portion is adjacent the brush shoe to a position wherein the extended radius profile portion is adjacent the brush shoe; and

wherein axial movement of the piston member in a first axial direction moves the brush shoe radially outwardly and axial movement of the piston member in a second axial direction allows the brush shoe to move radially inwardly.

2. The expandable brush of claim **1** further comprising:

a window formed within the housing; and

the brush shoe is radially movable through the window.

3. An expandable brush for cleaning a surrounding tubular member, the brush comprising:

a housing to be disposed within the surrounding tubular member;

a piston member disposed within and axially moveable within the housing;

a brush shoe that retains at least one brush bristle, the brush shoe being radially moveable with respect to the housing between a radially retracted position and a radially expanded position;

a rotatable cam member operably associated with the brush shoe and the piston member so that axial movement of the piston member in a first axial direction moves the brush shoe radially outwardly and axial movement of the piston member in a second axial direction allows the brush shoe to move radially inwardly, the rotatable cam member presenting a notched portion that interfits with a notched profile of the piston member;

the rotatable cam member further presenting an eccentric outer profile having a radially reduced profile portion and an extended radius profile portion and wherein axial movement of the piston member in a first axial direction moves the brush shoe radially outwardly by rotating the rotatable cam member from a position wherein the reduced profile portion is adjacent the brush shoe to a position wherein the extended radius profile portion is adjacent the brush shoe.

4. The expandable brush of claim **3** wherein the piston member disposed within and axially moveable within a flowbore within the housing.

5. The expandable brush of claim **3** further comprising:

a window formed within the housing; and

the brush shoe is radially movable through the window.

6. An expandable brush for cleaning a surrounding tubular member, the brush comprising:

a housing to be disposed within the surrounding tubular member;

a brush shoe that retains at least one brush bristle, the brush shoe being radially moveable with respect to the housing between a radially retracted position and a radially expanded position;

an axial flowbore formed within the housing;

a piston member disposed within and axially moveable within the flowbore;

a rotatable cam member operably associated with the brush shoe and the piston member so that axial movement of the piston member rotates the cam member to move the brush shoe to its radially expanded position, the rotatable cam member presenting a notched portion that interfits with a notched profile of the piston member; and

the rotatable cam member further presenting an eccentric outer profile having a radially reduced profile portion and an extended radius profile portion and wherein axial movement of the piston member in a first axial direction moves the brush shoe radially outwardly by rotating the rotatable cam member from a position wherein the reduced profile portion is adjacent the brush shoe to a position wherein the extended radius profile portion is adjacent the brush shoe.

7. The expandable brush of claim **6** further comprising:

a window formed within the housing; and

the brush shoe is radially movable through the window.

* * * * *